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Solid-state cultures of *Fusarium oxysporum* transform aromatic components of olive-mill dry residue and reduce its phytotoxicity

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Abstract

The present study mainly investigated the ability of solid-state cultures of the non-pathogenic *Fusarium oxysporum* strain BAFC 738 to transform aromatic components to reduce the phytotoxicity in olive-mill dry residue (DOR), the waste from the two-phase manufacturing process. Lignin, hemicellulose, fats and water-soluble extractives contents of DOR colonized by the fungus for 20 weeks were reduced by 16%, 25%, 71% and 13%, respectively, while the cellulose content increased by 25%. In addition, the ethyl acetate-extractable phenolic fraction of the waste was reduced by 65%. However, mass-balance ultra-filtration and size-exclusion chromatography experiments suggested that the apparent removal of that fraction, mainly including 2-(3,4-dihydroxyphenyl)ethyl alcohol and 2-(4-hydroxyphenyl)ethyl alcohol, was due to polymerization. Mn-peroxidase and Mn-independent peroxidase activities were found in *F. oxysporum* solid-state cultures, while laccase and aryl alcohol oxidase activities were not detected. Tests performed with seedlings of tomato (*Lycopersicum esculentum* L.), soybean (*Glycine maximum* Merr.), and alfalfa (*Medicago sativa* L.) grown on soils containing 6% (w/w) of bioconverted DOR (kg soil)$^{-1}$ showed that the waste's phytotoxicity was removed by 20 weeks-old fungal cultures. By contrast, the same material exhibited a high residual toxicity towards lettuce (*Lactuca sativa* L.).

Keywords: *Fusarium oxysporum*; Dry olive-mill residue; Phenols; Phytotoxicity

1. Introduction

The olive oil industry has a significant environmental impact due to the production of huge amounts of either a highly polluted wastewater or a solid residue, depending on the olive oil extraction process. In the last two decades Spain, the greatest producer of olive oil at a worldwide level has witnessed the increasing replacement of the three-phase extraction process by the so-called two-phase system. The latter technology for olive oil extraction consists of a continuous centrifugation two-phase process that generates a liquid phase (olive oil) and a solid organic waste (alpeorujo), which is then dried and extracted with solvents to obtain an extra yield of oil and a dry residue (DOR) (Vlyssides et al., 1998).

The two-phase extraction system yields about 800 kg of alpeorujo per ton of processed olives so that it has been calculated that the annual production of DOR in Spain approach four million tons (MAPA, 2002). Thus, the environmental risks associated with the production of huge amounts of DOR require the development of new technological procedures allowing a profitable and environmentally sound use of the waste.

One of the main drawbacks to the biological degradation and/or upgrading of olive-mill residues by either aerobic or anaerobic processes is due to the presence of phenols, which may occur both in monomeric (Capasso et al., 1992; Sampedro et al., 2004a) and polymeric form (Sayadi et al., 2000). In fact, polyphenols have been shown to be responsible for

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